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(54) MULTIPLE FREQUENCY ANTENNA

(57) Having as an object the ability to stably receive GPS signals, and to be capable of being mounted in an arbitrary location on a car body, a GPS antenna 10 and a matching board 9 are built into a cover 2. An antenna element 1 is connected to the matching board 9. The matching board 9 is arranged in a standing condition, the grounding effect of the GPS antenna is enhanced, and adverse affects are not generated even when a GPS satellite is at a low angle of elevation. Because the antenna element 1 is attached in an inclined condition from a vertical line, adverse affects are not generated even when a GPS satellite is at a low angle of elevation.

Fig. 3a

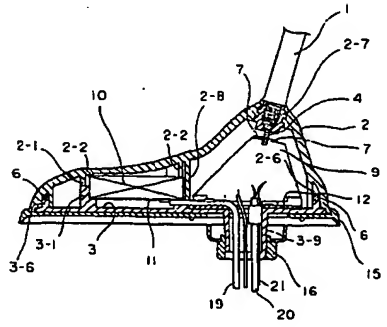
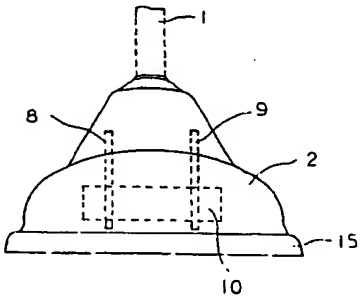


Fig. 3b



EP 0 862 239 A1

Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an antenna capable of receiving 4 wavebands, portable radiophone bands, FM radio bands, AM radio bands and GPS bands, and more particularly to an antenna that is well-suited for use as a roof antenna, which is mounted to the roof of a car body.

2. Description of the Related Art

There are various types of antennas that can be mounted to the body of a car. However, since reception sensitivity can be increased by mounting an antenna to the roof, which is the highest location on a car body, a roof antenna, which is mounted to the roof, has been preferred for some time.

Further, because an FM radio and AM radio are generally provided inside a car body, an antenna capable of receiving both FM radio bands and AM radio bands is convenient, and roof antennas, which are capable of receiving and sharing the use of both radio bands are in widespread use.

Further, car navigation systems, which make use of the global positioning system (GPS), and portable radiophones have been gaining popularity recently, and a GPS antenna is attached to a car body for a car navigation system, and a portable radiophone antenna is attached to a car body for a portable radiophone.

Furthermore, when a car is equipped with a keyless entry system, which locks and unlocks the doors via remotely operated wireless [transmissions], a keyless entry antenna is also attached to a car body.

However, since attaching various types of antennas to a car body independently like this both looks bad and makes maintenance and mounting work complicated, a multi-frequency antenna, which receives portable radiophone bands, FM radio bands, AM radio bands, GPS bands, and keyless entry bands with a single antenna is desirable.

An example of the configuration of this type of multi-frequency antenna disclosed in previously-proposed Kokai No. Hei 6-132714 is shown in Fig. 7. In Fig. 7, the retractable rod antenna 101 is a 3-waveband antenna capable of receiving portable radiophone bands, FM radio bands and AM radio bands, the flat radiating element 102 is a GPS antenna, which receives GPS signals, and the loop radiating element 103 is a keyless entry antenna, which receives keyless entry signals.

Each of these antennas is mounted on the upper surface of a main unit 100. A metal plate 104 is provided on the upper part of the main unit 100, and the flat radiating element 102 and loop radiating element 103 are formed on top of the plate 104 with a dielectric layer between them. Because this plate functions as the ground plane, the flat radiating element 102 and loop radiating element 103 are operated as microstrip antennas. A protective cover 105 is also formed on top of the flat radiating element 102 and loop radiating element 103.

However, with the above-described multi-frequency antenna, if the retractable rod antenna 101 is to be stored so that it does not protrude from the upper surface, a storage space in which the rod antenna 101 is stored is required in the internal cavity of the fitting via which the multi-frequency antenna is mounted. Therefore, the multi-frequency antenna can be mounted to the trunk lid or fender of a car body, but it cannot be mounted to a location such as the roof, where a storage space does not exist.

Now, it is known that the angle of elevation of a radio wave sent from a GPS satellite is often a low angle of elevation.

However, when a multi-frequency antenna is mounted to a trunk lid or fender, depending on the position of the GPS satellite, there is the danger that a radio wave from the satellite will be blocked by the car body.

Further, as described above, when a keyless entry loop radiating element 103 is provided so that it surrounds the flat radiating element 102, which is the GPS antenna, since the angle of elevation of a GPS radio wave is often a low angle of elevation, depending on the position of the GPS satellite, this can have an extremely adverse affect on the sensitivity of the GPS antenna.

Accordingly, an object of the present invention is to provide a multi-frequency antenna, which can be mounted to an elevated location such as the roof of a car body, where a storage space does not exist, and which is designed so as not to adversely affect the operation of a GPS antenna.

SUMMARY OF THE INVENTION

To achieve the above-described object, a multi-frequency antenna of the present invention comprises a whip antenna element that is capable of receiving 3 wavebands: AM radio bands, FM radio bands and portable radiophone bands; a circuit board, which, in addition to making it possible to mount this antenna element, comprises at least a matching means, a splitting means and an amplifying means; and an antenna case, inside which a GPS antenna is stored. This antenna case comprises a conductive base; and a cover that fits to this base. The above-described circuit board is affixed in the above-described base in a standing condition, and a GPS antenna storage part for mounting a GPS antenna so that it is perpendicular to the above-described circuit board is integrally formed into the above-described base part.

Further, the above-described multi-frequency antenna can be affixed to the roof of a car body, and the above-described GPS antenna storage part is formed

using a lug that encloses the entire circumference of the above-described GPS antenna. The above-described GPS antenna storage part is designed so as to shield a circuit board, which is positioned on the rear face of the above-described GPS antenna.

And furthermore, the above-described antenna element is inclined approximately 20° to 35° from a vertical position.

In accordance with the present invention, since an antenna storage part is not required in the lower part of the multi-frequency antenna, when mounted to a car body, it becomes possible to mount this antenna in an elevated location such as the roof, where no storage space exists. Therefore, it is possible to prevent a situation wherein a car body or other object to which a multi-frequency antenna is mounted blocks the GPS radio waves intended for the GPS antenna, thus making it impossible to receive these GPS radio waves.

Furthermore, because the circuit board is positioned orthogonal to the GPS antenna, the grounding effect of the GPS antenna can be enhanced. And furthermore, the fact that the circuit board is arranged in a standing condition, and the antenna element is arranged in an inclined condition enables affects on the GPS antenna to be prevented as much as possible even when GPS radio waves arrive at a low angle of elevation.

Further, because the circuit board, which performs GPS antenna signal processing, is shielded, the GPS antenna can be operated in a stable condition.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a diagram showing an exploded oblique view depicting a portion of the configuration of an embodiment for the multi-frequency antenna of the present invention;

Fig. 2 is a diagram showing an exploded oblique view depicting another portion of the configuration of an embodiment for the multi-frequency antenna of the present invention;

Fig. 3 is a cross-sectional view and a front view showing the configuration of an embodiment for the multi-frequency antenna of the present invention;

Fig. 4 is a diagram showing a configuration of a base and cover for the multi-frequency antenna of the present invention;

Fig. 5 is a diagram showing a configuration of a board bracket for the multi-frequency antenna of the present invention;

Fig. 6 is a diagram showing a configuration of a ground bracket for the multi-frequency antenna of the present invention; and

Fig. 7 is a diagram showing a configuration of a conventional multi-frequency antenna.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Exploded oblique views depicting the configuration of an embodiment for the multi-frequency antenna of the present invention are shown in Fig. 1 and Fig. 2.

In these figures, the antenna element 1 comprises a linear element 1-1, a wind noise prevention means 1-2, which wraps coil-like around element 1-1; and an antenna base 1-3, which is molded from a flexible synthetic resin such as rubber. A trap coil can be inserted inside this antenna base 1-3 and connected to element 1-1. And a breakage-prevention coil spring, which is part of the antenna element 1, can also be provided inside the antenna base 1-3.

A fastening screw 1-4 for mounting the antenna element 1 to a cover 2 is provided so as to protrude from the bottom of this antenna element 1.

Also, the electrical length from the tip of the antenna element 1 to the fastening screw 1-4, which is the tip of the antenna base, is approximately ¼ the wavelength of the FM radio band, and the electrical length from the fastening screw 1-4 to the bottom of the trap coil inside the antenna base 1-3 is approximately ¼ the wavelength of the portable radiophone band.

Then, an element connection fitting 2-7, into which the fastening screw 1-4 provided at the bottom of the antenna element 1 is screwed, is provided in a watertight condition on the cover 2, to which the antenna element 1 is affixed.

Further, this cover is configured so as to be fitted to the Fig. 2-depicted base 3, which is covered over its entire surface with a metal or conductive plating.

A board bracket 12, which is prepared by processing a metal plate, is fastened to the base 3. An amp board 8, which incorporates an amplification circuit, and a matching board 9, which incorporates a tuner and splitter, are affixed perpendicularly to this board bracket 12. A connection piece 7 for electrically connecting the antenna element 1 to the matching board 9 is affixed using solder, and a connection screw 4, which is inserted into the center of the element connection fitting 2-7 provided on the top of the cover 2, is screwed, together with a waterproof washer, to this connection piece 7, thereby connecting the element connection fitting 2-7 electrically to the connection piece 7.

A storage part 3-10, which stores a rectangular GPS antenna 10, is formed in the base 3, and the GPS antenna 10 is stored inside this storage part 3-10, together with a wave-shaped wave spring 11. Then, when the cover 2 is fitted onto and fastened to the base 3, the GPS antenna 10 is pressed against the base 3 by a presser lug formed inside the cover 2, and the GPS antenna 10 is held inside the storage part 3-10.

Further, in the state wherein the cover 2 is fitted to the base 3, the cover 2 is affixed to the base 3 by screwing 4 fastening screws 14 from the backside of the base 3 into screw holes formed on the inside of the cover 2.

And a fastening screw part 3-9, which is inserted into a mounting hole formed in a car body or other object to which a multi-frequency antenna is mounted, protrudes from the backside of the base 3, and on O ring 13 is inserted into this fastening screw part 3-9 to make it waterproof.

And furthermore, a buffer pad 15 comprising a flexible material is fitted onto the bottom part of the base 3. This makes it possible to prevent scratching the object to which a multi-frequency antenna is being mounted when mounting the multi-frequency antenna to this object by screwing a nut 16 onto the fastening screw part 3-9, which protrudes to the backside of the object to which the multi-frequency antenna is being mounted.

And furthermore, so that the cover 2 is fitted to the base 3 in a watertight condition, a groove is formed around the periphery of the bottom part of the cover 2, and a waterproof packing 6 is inserted into this groove.

Also, a power cord 18, GPS cable 19, telephone cable 20, and radio cable 21 are drawn into the inside of the object to which the multi-frequency antenna is being mounted by passing them through a through hole formed in the base 3, and through the cylindrical-shaped fastening screw part 3-9.

In this case, the ground parts of the telephone cable 20 and radio cable 21 are connected electrically by a ground bracket 17, and both cables are bound together. Then, using a binding means 22, these are bound together with the power cord 18.

Further, respective connectors for connection are provided at the ends of each cable and the cord.

Fig. 3 (a) shows a cross-sectional view, and Fig. 3 (b) shows a front view of the thus-configured multi-frequency antenna of the present invention when it is assembled. Further, Fig. 4 (a) shows the configuration of the inside of the cover 2, and Fig. 4 (b) shows the configuration of the upper surface of the base 3. The following is a description of the multi-frequency antenna of the present invention with reference to these figures.

As shown in these figures, the connection screw 4, which is inserted into the element connection fitting 2-7 integrated into the cover 2, is screwed into the connection piece 7, which is fastened to the matching board 9. Therefore, a signal received by the antenna element 1, which is screwed into the element connection fitting 2-7, is guided to the matching board 9 via the element connection fitting 2-7 and connection screw 4. And then, each received signal, which is split and amplified in the matching board 9 and amp board 8 (not shown in the figure), is guided to the inside of the car body, which is the object to which the multi-frequency antenna is mounted, by the telephone cable 20 and radio cable 21.

Also, the telephone cable 20 and radio cable 21 are drawn out through the fastening screw part 3-9, which is formed into a cylindrical shape.

The matching board 9 and amp board 8 are affixed so they are in a standing condition in the board bracket 12. The ground parts of both boards 8, 9 are connected electrically to the board bracket 12 at this time, and it is further grounded to the object to which the multi-frequency antenna is mounted via the base 3.

Further, the GPS antenna 10 is stored and held in the space formed by the cover 2 and base 3. The GPS antenna 10 is rectangular in shape, and the GPS antenna is stored in a rectangular storage part 3-10, which comprises a lug 3-1, which is arranged in a standing condition on the base 3 so as to enclose the periphery of this GPS antenna 10. The top surface of this GPS antenna 10 is pressed by presser lugs 2-2, which are formed at 4 locations on the inner surface of the cover 2. This holds the GPS antenna 10 inside the storage part 3-10.

Also, on the outer periphery of the presser lugs 2-2, which are formed in the cover 2, a lug 2-1, which is practically the same shape as the lug 3-1 formed in the base 3, and which enables the storage of the GPS antenna 10, is formed opposite the lug 3-1 .

Further, a wave spring 11 is inserted under the GPS antenna 10 so as to securely hold the GPS antenna 10 inside the storage part 3-10. A circuit board, which incorporates circuits that process GPS signals, is provided on the rear face of the GPS antenna 10. Because this circuit board is positioned inside the conductive storage part 3-10, it is shielded by the storage part 3-10. Therefore, the GPS antenna 10 is able to operate stably, and GPS signals are guided via the GPS cable 19 to the inside of the object to which the multi-frequency antenna is mounted.

In this case, a groove 3-8 for drawing out the GPS cable 19 is formed in the lug 3-1, and the GPS cable 19, which is inserted into this groove 3-8, is pressed and held by a cable presser lug 2-8, which is formed so as to further protrude from the lug 2-1 formed in the cover 2.

Further, a grooved part 2-6 is formed around the entire periphery of the bottom part of the cover 2, and a waterproof packing 6 is inserted into this grooved part 2-6. A lug part 3-6, which is fitted into this grooved part 2-6, is formed around the entire periphery of the base 3. Consequently, as shown in the figure, when the cover 2 is fitted to the base 3, the lug part 3-6 presses against the waterproof packing 6 to create a water tight fit.

A metal or conductive plating is formed over the entire surface of the base 3, making it conductive. A flexible pad 15 is positioned on the bottom surface of the base 3, [the base 3] is placed and held on top of the object to which the multi-frequency antenna is being mounted, and the fastening screw part 3-9 is inserted into a rectangular mounting hole formed in the object to which the multi-frequency antenna is being mounted. The base 3 is affixed to the object to which the multi-frequency antenna is being mounted by screwing a nut 16 onto the fastening screw part 3-9, which protrudes to the rear face of the object to which the multi-frequency antenna is being mounted.

Also, as shown in Fig. 3 (b), the GPS antenna 10 is arranged practically parallel to the base 3, but the amp

board 8 and matching board 9 are arranged in a standing condition.

Consequently, the effective ground area is increased, and the grounding effect of the GPS antenna 10 is enhanced.

Furthermore, even if a GPS satellite has a low angle of elevation, the affects of the circuit board on the GPS antenna 10 can be prevented as much as possible.

Further, the antenna element 1 is mounted in an inclined condition of approximately 20° to 35° relative to a vertical line. Consequently, even if a GPS satellite has a low angle of elevation, the affects of the antenna element 1 on the GPS antenna 10 can be prevented as much as possible.

Next, the configuration of the board bracket 12 is shown in Fig. 5. The board bracket 12 is prepared by processing a metal plate as shown in Fig 5, with a pair of circuit board clamps 12-1, 12-2 formed on each of the two long sides. This circuit board clamp 12-1 is the clamp that secures the matching board 9, and circuit board clamp 12-2 is the clamp that secures the amp board 8. Circuit board clamps 12-1, 12-2 are bifurcated, and the space between the two parts is practically equivalent to the thickness of the circuit boards 8, 9 And, as shown in the figure, the circuit boards 8, 9 are positioned by mating the notches 8-2, 9-2 formed in the circuit boards 8, 9, respectively, with the circuit board clamps 12-1, 12-2.

Also, after placing and holding the circuit boards 8, 9 on top of the circuit board clamps 12-1, 12-2, the circuit boards 8, 9 are affixed to the board bracket 12 by soldering the ground parts 8-1, 9-1 of the circuit boards 8, 9 to the circuit board clamps 12-1, 12-2 The ground parts 8-1, 9-1 of the circuit boards 8, 9 are connected electrically to the board bracket 12 at this time

Further, a pair of raised tabs 12-3 are used as cable support raised tabs for the GPS cable Furthermore, another pair of raised tabs 12-4 are raised tabs for affixing by soldering a ground bracket 17 described below, and through hole 12-5 is a through hole for passing various cables through.

And furthermore, fitting hole 12-7 formed in 3 locations are fitting holes which mate with fitting lugs 3-11 formed in the above-described base 3 shown in Fig 4 (b). The board bracket 12 is positioned on the base 3 by this mating, and it is affixed by squeezing the fitting lugs 3-11.

Next, the configuration of a ground bracket 17 is shown in Fig. 6. Fig. 6 (a) is a side view of the ground bracket 17, Fig. 6 (b) is a front view of the ground bracket 17, and Fig. 6 (c) is a top view of the ground bracket 17.

As shown in these figures, a holder 17-3, which holds a relatively thick radio cable 21, and a holder 17-4, which holds a relatively thin telephone cable 20, are formed in the ground bracket 17. These holders 17-3, 17-4 hold the respective cables 20, 21, which are soldered from a window part 17-2 formed in the side. This connects the ground bracket 17 electrically to the ground parts of the cables 20, 21.

Further, an overhang part 17-1 protrudes from the side of the ground bracket 17. This overhang part 17-1 is soldered to the soldering part 12-6 between the pair of raised tabs 12-4 on the board bracket 12 shown in Fig. 5.

This affixes and electrically connects the ground bracket 17 to the board bracket 12. Therefore, the ground parts of the cables 20, 21 are grounded by the board bracket 12. Further, it is possible to draw the cables 20, 21 out vertically.

Also, the antenna element 1 in the multi-frequency antenna of the present invention is a 3-frequency antenna, but the present invention is not limited to this type of antenna element . A 2-frequency AM band and FM band antenna can also be used.

Because the present invention is configured as described above, there is no need for an antenna storage part on the bottom of the multi-frequency antenna, and when mounting [the present invention] to a car body, it can be mounted to a high location such as the roof where a storage space does not exist. Therefore, it is possible to prevent the GPS radio waves received by a GPS antenna from being blocked by the car body or other object to which the present invention is mounted.

Furthermore, because the circuit board is positioned perpendicular to the GPS antenna, the grounding effect of the GPS antenna can be enhanced. And further, the fact that the circuit board is arranged in a standing condition, and the antenna element is positioned in an inclined condition, enables the affects on the GPS antenna to be prevented as much as possible even when GPS radio waves arrive at a low angle of elevation.

Further, because the circuit board, which processes signals received by the GPS antenna, is shielded, the GPS antenna can be stably operated.

Claims

1. A multi-frequency antenna, comprising:

   a whip antenna element, capable of receiving at least AM radio bands and FM radio bands; and

   an antenna case, which enables the attachment of said antenna element, and which stores internally a GPS antenna, and a circuit board, which comprises at the least matching means, splitting means and amplifying means, said multi-frequency antenna being characterized in that said antenna case comprises a conductive base, and a cover that fits onto said base, said circuit board is affixed to said base in a standing condition, and a GPS antenna storage part for mounting a GPS antenna is

integrally formed in said base so that it is orthogonal to said circuit board.

2. The multi-frequency antenna according to Claim 1 wherein said antenna is affixed to the roof of a car body.

3. The multi-frequency antenna according to Claim 1 wherein said GPS antenna storage part formed in said conductive base is formed using a lug, which encloses the entire periphery of said GPS antenna, and a circuit board, which is positioned on the rear face of said GPS antenna is shielded by said GPS antenna storage part.

4. The multi-frequency antenna according to Claim 1 wherein said antenna element is inclined from a vertical position by approximately 20° to 35°, and is attached to said antenna case.

Fig. 1

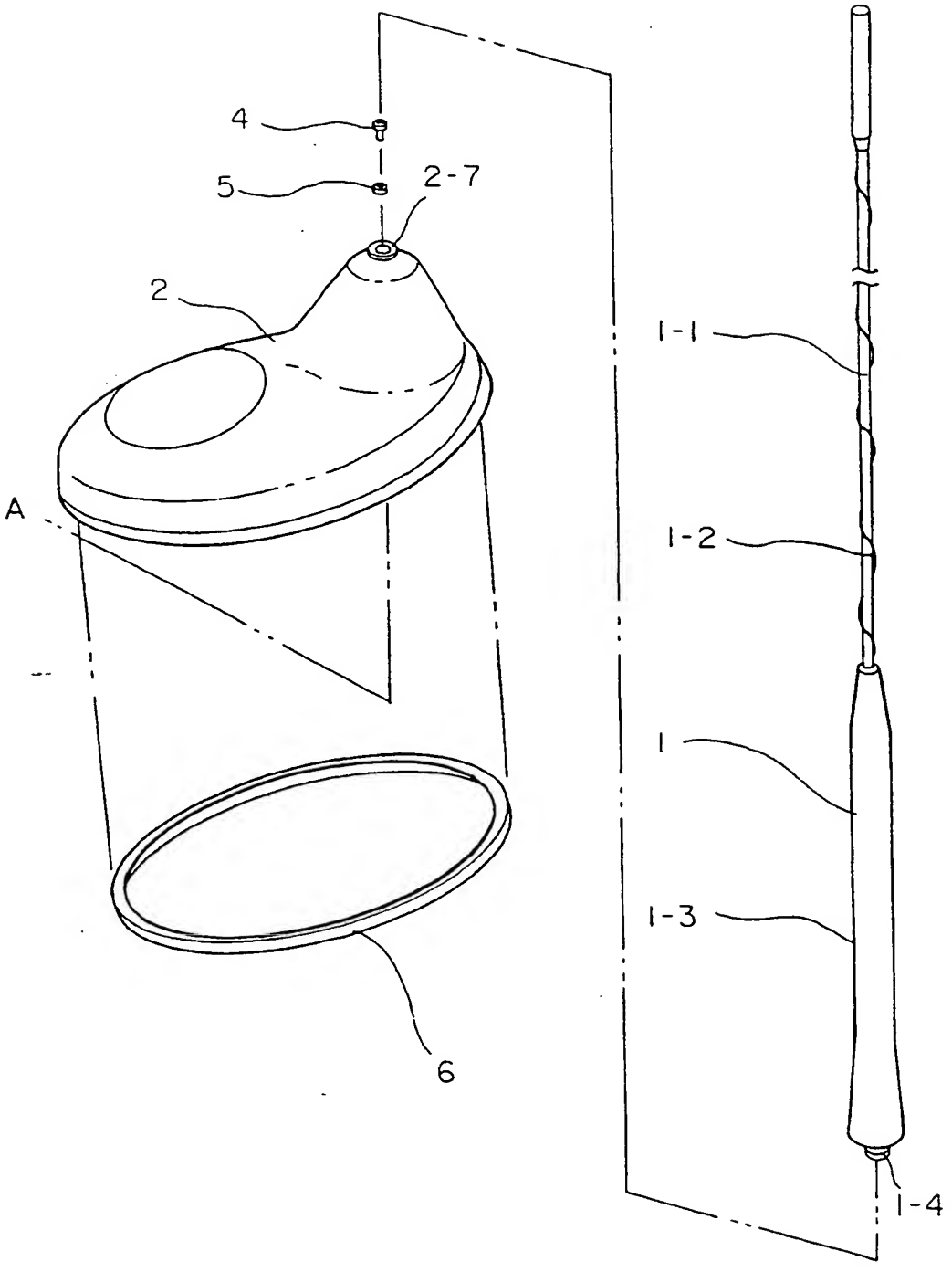


Fig. 2

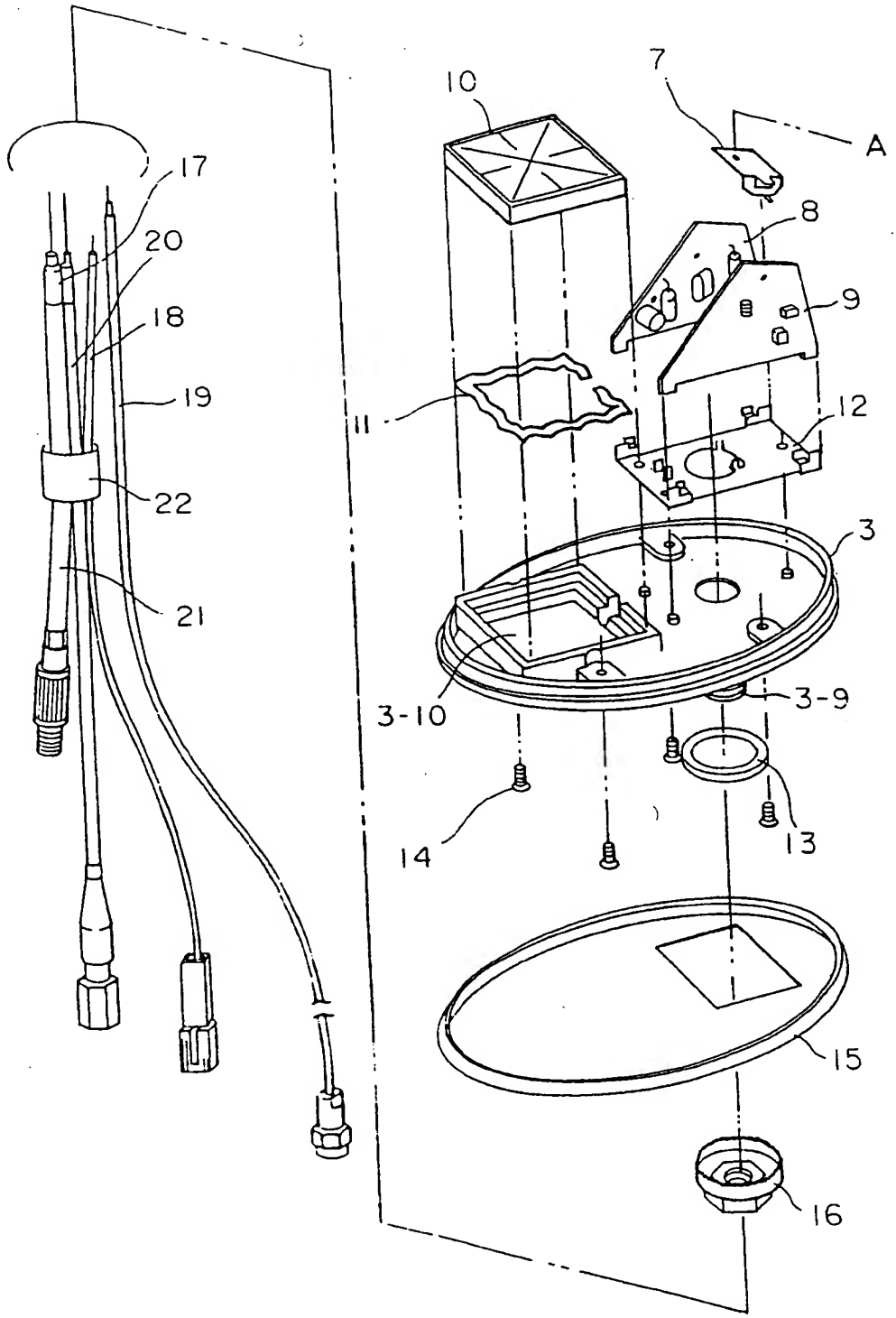


Fig. 3a

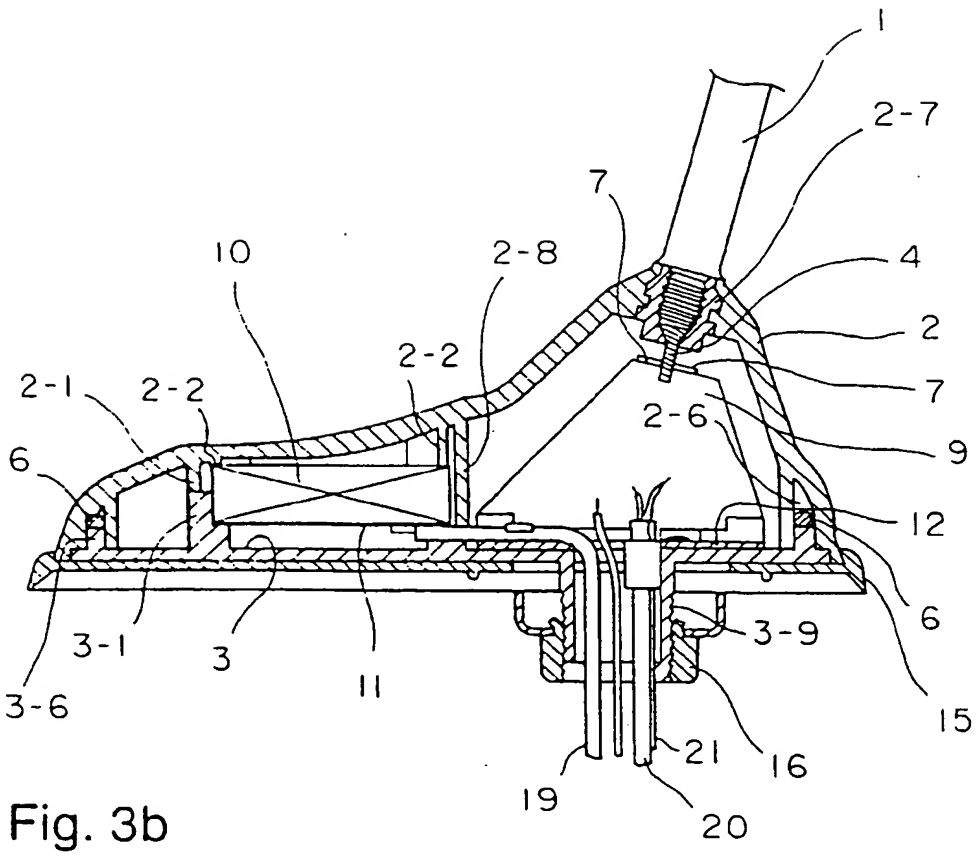

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Fig. 3b

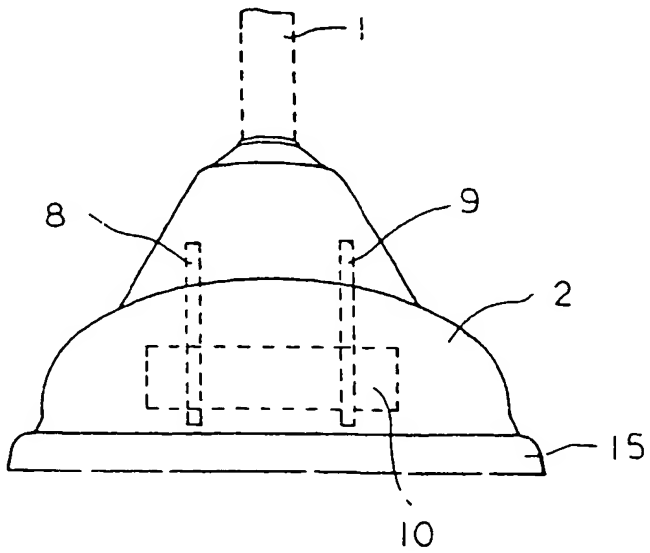
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Fig. 4a

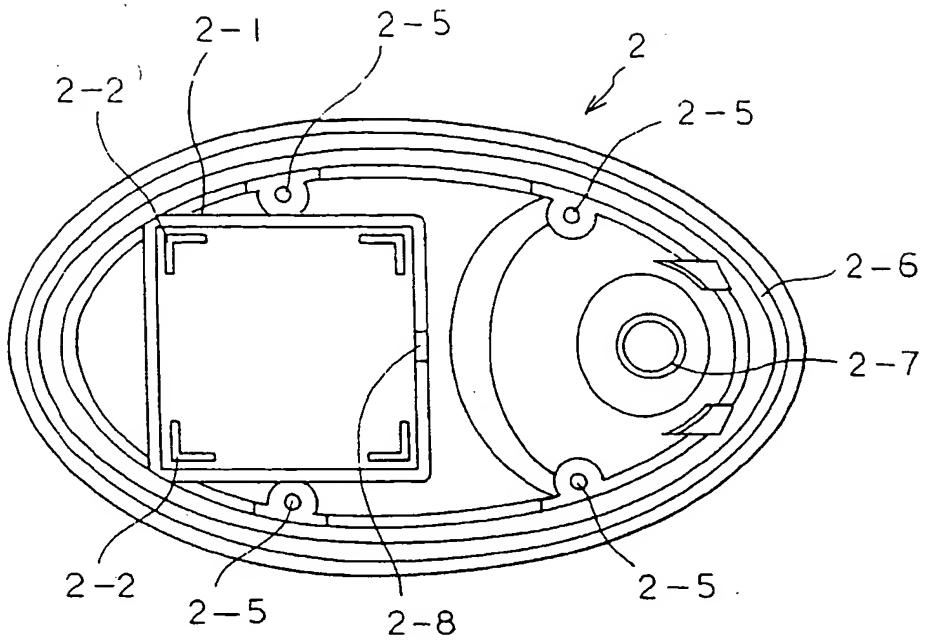


Fig. 4b

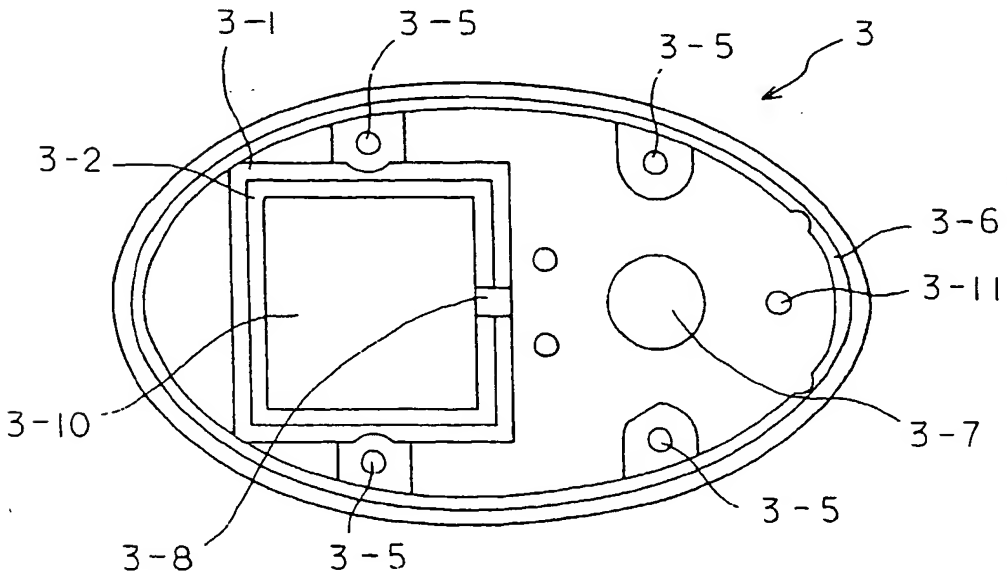


Fig. 5

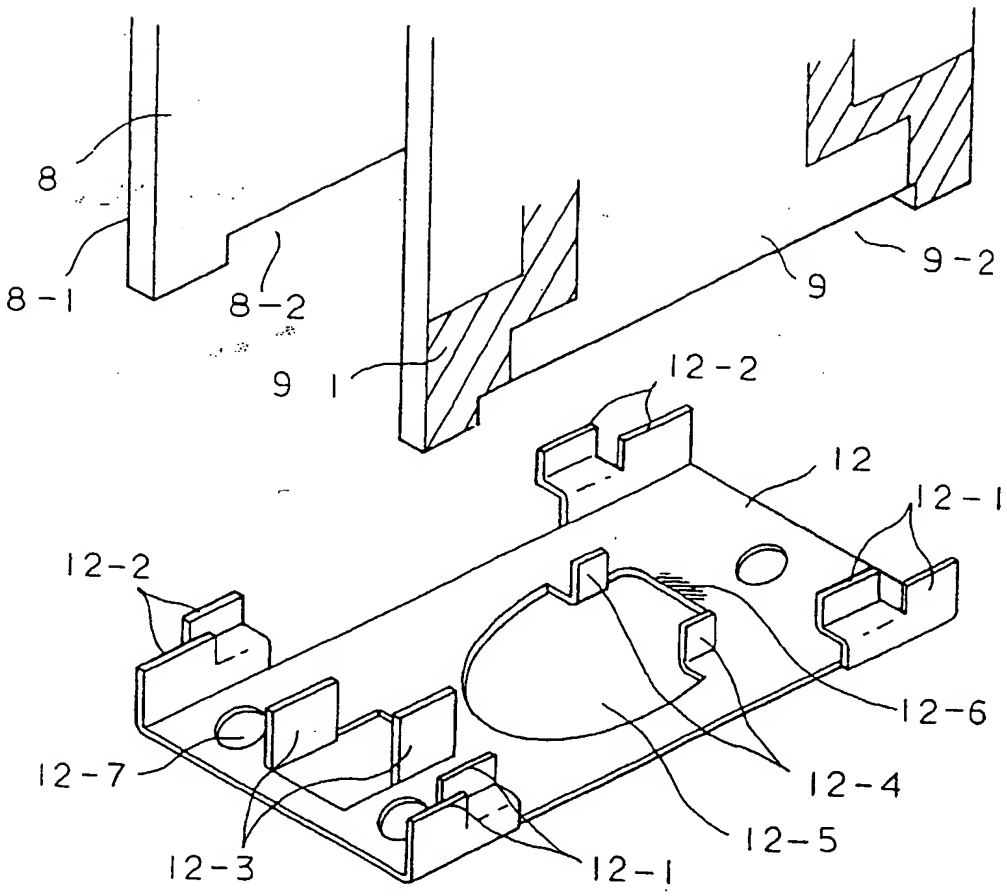


Fig. 6a

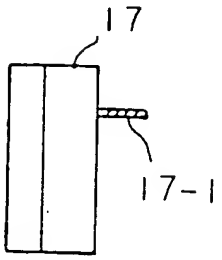


Fig. 6b

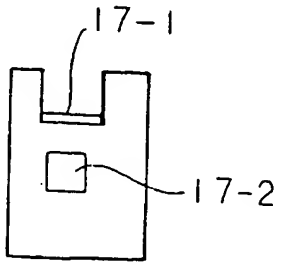


Fig. 6c

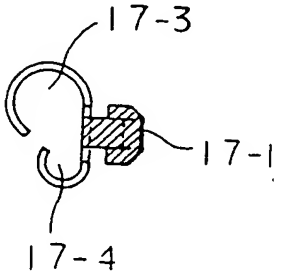
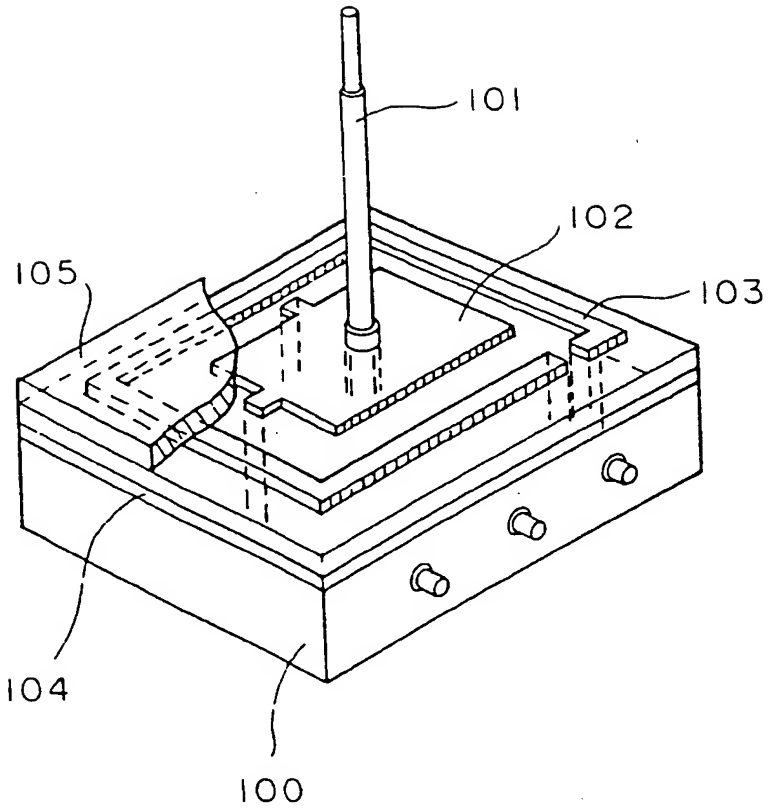


Fig. 7



PRIOR ART

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP97/03159

A. CLASSIFICATION OF SUBJECT MATTER
Int. Cl^6 H01Q5/00, H01Q1/22, H01Q21/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int. Cl^6 H01Q5/00, H01Q1/22, H01Q21/30

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1926 - 1997 Jitsuyo Shinan Toroku Koho 1996 - 1997
Kokai Jitsuyo Shinan Koho 1971 - 1997
Toroku Jitsuyo Shinan Koho 1994 - 1997

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP, 7-94929, A (Nippon Antena K.K.), April 7, 1995 (07. 04. 95), Claim 1 & EP, 637093, A & US, 5451967, A	1 - 4
A	JP, 8-204442, A (Mitsumi Electric Co., Ltd.), August 9, 1996 (09. 08. 96), Claims 1 to 3 (Family: none)	1 - 4
PA	JP, 8-335824, A (Harada Kogyo K.K.), December 17, 1996 (17. 12. 96), Claims 1, 2 & EP, 747993, A	1 - 4

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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